SECTION 16001

EXTERIOR POWER DISTRIBUTION SYSTEMS

1 GENERAL

1.1 SUMMARY

1.1.1 Section Includes

This section includes requirements for the provision of the exterior power distribution systems.

1.1.2 Components Included

This section includes, but is not limited to, requirements for wire and cable, conduit and fittings, transformers, surge arresters, fuses, secondary service switchboards and sections, multi-way sulfur hexafluoride (SF6) selector switches, metering and UCS equipment, and grounding and bonding equipment. The color shall be consistent for all equipment - "Olive Green", Munsell number 76Y/3.29/1.5 per ASTM D 1535. Paint coating shall comply with NEMA ICS6, corrosion resistance test ANSI C37.20.

1.2 QUALITY ASSURANCE

1.2.1 Cable Splicer's/Terminator's Qualifications

Submit for approval, 30 days before splices or terminations are to be made in medium voltage (5 kV to 35 kV) cables the name and qualifications of the cable splicer/terminator. The certification shall indicate that the individual has had three or more years recent experience splicing and terminating medium voltage cables. The certification shall also list a minimum of three splices/terminations that have been in operation for more than one year. In addition, the individual may be required to perform a dummy or practice splice/termination in the presence of the Contracting Officer, before being approved as a qualified cable splicer.

1.3 SUBMITTALS

1.3.1 Exterior Power Systems

Submit the following shop drawings, procedures and catalog data to the Navy Public Works Center for approval:

a. Transformers and accessories
b. SF6 Switches
c. Cables
d. Terminations
e. Conduit
f. Secondary switchboard and components
g. Metering equipment
h. Circuit Breakers
i. Utility control system wiring diagram
j. Field testing plan

2 PRODUCTS

2.1 SYSTEM PERFORMANCE

2.1.1 Exterior Power Distribution System Requirements

The design and construction of the exterior electrical power distribution system shall conform with ANSI C2. Encase all underground conduit in concrete.
The electrical point of connection is as indicated where the electrical characteristics are:

a. Voltage: [ ] kilovolts

b. Available symmetrical short circuit rating shall be [derived by calculation][as indicated].

The Contractor shall provide all work and equipment as indicated on the drawings.

2.2 COMPONENT PERFORMANCE

2.2.1 Underground Electrical Work

2.2.1.1 Wire and Cable

2.2.1.1.1 600 Volt Wires and Cables

Service entrance conductors shall be single conductor type USE. Conductor size and number of conductors in each conduit shall be as indicated. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Conductor identification shall be by 3 inch wide color-coded tape. Conductors No. 10 AWG and smaller shall be solid copper. Conductors No. 8 AWG and larger shall be stranded copper. All conductors shall be copper.

2.2.1.1.2 Medium Voltage Cable

Cable (conductor) sizes are designated by American Wire Gauge (AWG) and Thousand Circular Mils (Kcmil). Conductor and conduit sizes indicated are for copper conductors unless otherwise noted. Insulated conductors shall have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout cable length. Wires and cables manufactured more than 12 months prior to date of delivery to the site shall not be accepted.

Medium voltage cable shall be single conductor Ethylene Propylene Rubber (EPR) insulated, shielded power cable rated at 15kv, 133% insulation level. The cable shall be capable of operating continously in both wet and dry locations at 105 degrees C for normal operation, 130 degrees C under emergency operation conditions and 250 degrees C under short circuit conditions. The conductor size is specified in the plans. The conductor shield, insulation, and the insulation shield shall be applied continuously in the same pass by triple extrusion process. The cable shall be insulated, jacketed and tested in accordance with AEIC CS6, in the same plant by the same manufacturer. Certified AEIC qualification data shall be required prior

to order placement, and certified test reports are to be supplied at the time of shipment. Cable ends shall be sealed. Cable shall be equipped with a factory-installed cable pulling eye. Pulling eye shall not exceed the outside diameter of the cable.

CONDUCTOR: Shall be class B stranded annealed copper per Part 2 of ICEA S-68-516.

CONDUCTOR SHIELD: Shall be extruded black, semi-conducting thermosetting compound applied directly over the conductor. The conductor shield shall be thermally and chemically compatible with the conductor and insulation. Conductor shield may be uniformly and firmly bonded to the overlaying insulation and to be free stripping from the conductor. The thickness of the conductor shall conform to AEIC CS6.

INSULATION: Shall be Ethylene Propylene Rubber conforming to AEIC CS6 and shall have a minimum average thickness of 220 mils.

INSULATION SHIELD: Shall be extruded black, semi-conducting thermosetting compound applied directly over the insulation. The insulation shield shall be thermally and chemically compatible with the conductor and insulation. The insulation shield shall be free stripping leaving no conducting particle or other residue on the insulation surface. The thickness of the insulation shield shall conform to AEIC CS6.

COPPER TAPE SHIELD: Shall have a thickness of 5 mils, helically applied over the insulation shield with a minimum of 12.5% overlap.

JACKET: Shall be chlorosulfonated polyethylene with a minimum thickness of 80 mils.

2.2.1.2 Medium Voltage Cable Joints

Provide joints (splices) in accordance with IEEE 404 suitable for 25 kV voltage and insulation level, and rated for continuous immersion in water. Upon request, supply manufacturer's design qualification test report in accordance with IEEE 404. Connectors for joint shall be tin-plated electrolytic copper, having ends tapered and having center stops to equalize cable insertion. Connectors shall be rated for voltage of 35 kV minimum.

a. Heat-shrinkable joint: Consists of a uniform cross-section heat-shrinkable polymeric construction with a linear stress relief system, a high dielectric strength insulating material, and an integrally bonded outer conductor layer for shielding. Replace original cable jacket with a heavy-wall heat-shrinkable sleeve with hot-melt adhesive coating.

2.2.1.3 Fireproofing Tape

Furnish tape composed of a flexible conformable unsupported intumescent elastomer. Tape shall be not less than .762 mm thick, noncorrosive to cable sheath, self-extinguishing, noncombustible, and shall not deteriorate when subjected to oil, water, gases, salt water, sewage, and fungus.

2.2.2 Conduit

PVC type EB-35 and fittings per NEMA TC-9

2.2.3 Pad-mounted Transformers

Equipment shall comply with applicable articles of IEEE C57 . Audible sound levels shall comply with the following:

kVA	DECIBELS (MAX)
75	51
112.5	55
150	55
225	55
300	55
500	56
750	57
1000	58

2.2.3.1 Compartments

The high- and low-voltage compartments shall be separated by steel isolating barriers extending the full height and depth of the compartments. Compartment doors: hinged lift-off type with stop in open position and three-point latching.

2.2.3.1.1 High Voltage, Dead-Front

High-voltage compartment shall contain the incoming line, insulated high-voltage dead-break connectors, bushing well inserts, six high-voltage bushing wells configured for loop feed application, access to oil-immersed fuses, dead-front surge arresters, tap changer handle, connector parking stands and ground pad.

a. Insulated high-voltage dead-break connectors: Provide elbow connectors as specified for the SF6 switch.

b. Bushing well inserts: IEEE 386, 600 amperes, 25 kV Class. Provide a bushing well insert for each bushing well unless indicated otherwise.

c. Provide bayonet oil-immersed, expulsion fuses in series with oil-immersed, partial-range, current-limiting fuses. Bayonet fuse links shall sense both high currents and high oil temperature in order to provide thermal protection to the transformer. Coordinate transformer protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse. In order to eliminate or minimize oil spills, the bayonet fuse assembly shall include an oil retention valve inside the housing which closes when the fuse holder is removed and an external drip shield. Warning shall be conspicuously displayed within the high-voltage compartment cautioning against removing or inserting fuses unless the load-break switch is in the open position and the tank pressure has been released.

   Bayonet fuse assembly: 150 kV BIL.

   Oil-immersed current-limiting fuses: ANSI C37.47; 50,000 rms amperes symmetrical interrupting rating at the system voltage specified. Provide three spare fuses.

d. Surge arresters: ANSI/IEEE C62.11, rated 12 kV, with maximum continuous operating voltage of 10.2 kV rms line-to-neutral, discharge class of 10 kA, fully shielded, dead-front, metal-oxide-varister, intermediate class, elbow type with resistance-graded gap, suitable for plugging into bushing well inserts. Provide three arresters for radial feed circuits.

e. Parking stands: Provide a parking stand near each bushing well.

2.2.3.1.2 Low Voltage

Low-voltage compartment shall contain low-voltage bushings with NEMA spade terminals, accessories, stainless steel diagrammatic transformer nameplate, and ground pad.

a. Accessories shall include drain valve with sampler device, fill plug, pressure relief device with contacts, liquid level gage with contacts, pressure-vacuum gage with contacts, and dial type thermometer with contacts and 4-20mA output and maximum temperature indicator. All contacts and 4-20mA outputs shall be wired to the UCS.

b. Copper NEMA spade lug with more than six holes shall have additional support at the ends of the lugs, and shall be supported from above.

2.2.3.2 Transformer

a. Oil-insulated [less-flammable liquid-insulated] [edible less flammable liquid], two winding, 60 hertz, 65 degrees C rise above a 30 degrees C average ambient, self-cooled type.

b. Transformer shall be rated as indicated, 95 kV BIL.

c. Transformer voltage ratings, as indicated.

d. Tap changer shall be externally operated, manual type for changing tap setting when the transformer is de-energized. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage. Tap changers shall clearly indicate which tap setting is in use.

e. Minimum tested impedance shall not be less than 3.5 percent at 85 degrees C, or as indicated.

f. Transformer shall include lifting lugs and provisions for jacking under base. The transformer base construction shall be of the fabricated type and suitable for using rollers or skidding in any direction. Provide transformer top with an access handhole. Transformer shall have its kVA rating conspicuously displayed on its enclosure. The transformer shall have an insulated low-voltage neutral bushing with lugs for ground cable, and with removable ground strap.

g. Alarm contacts for monitoring of temperature, pressure, vacuum and liquid level via contacts for wiring to the UCS. Temperature monitoring shall include 4-20mA output.

2.2.3.3 Insulating Liquid

a. Mineral oil: ASTM D 3487, Type II, tested in accordance with ASTM D 117. Provide identification of transformer as "non-PCB" and "Type II mineral oil" on the nameplate.

[b. Less-flammable transformer liquids: NFPA 70 and FM P7825for less-flammable liquids having a fire point not less than 300 degrees C tested per ASTM D 92 and a dielectric strength not less than 33 kV tested per ASTM D 877. Do not provide nonflammable transformer liquids including askarel and insulating liquids containing polychlorinated biphenyls (PCB's) and tetrachloroethylene (perchloroethylene), chlorine compounds, and halogenated compounds. Do not provide silicone. Provide identification of transformer as "non-PCB" and "manufacturer's name and type of fluid" on the nameplate.]

2.2.3.4 Corrosion Protection

Bases and cabinets of transformers shall be corrosion resistant and shall be fabricated of stainless steel conforming to ASTM A 167, Type 304 or 304L. Base shall include any part of pad-mounted transformer that is within 3 inches of concrete pad. Form cabinets of stainless steel sheets no less than No. 13 U.S. gage. Paint bases, cabinets, and tanks. Paint coating system shall comply with ANSI C57.12.28 regardless of base, cabinet, and tank material.

2.2.3.5 SPARE PARTS

a. Provide 1 set of three 15kV spare fuses.

b. Provide three wrenches for high voltage compartment.

c. Provide 6 spare pad locks keyed to AASM1.

2.2.4 Secondary Service Switchboards

Provide NEMA 3R, freestanding switchboard. The switchboard shall be designed for outdoor service with insect and rodent-proof screened ventilation louvers and gasketing to insure a weatherproof assembly under rain, snow, sleet and hurricane conditions. The switchboard shall be the product of one manufacturer. Switchboard shall consist of main and feeder vertical sections an the utility control cabinet as described below. External doors shall have a minimum of five hinges and 3-point latching mechanisms and shall be padlockable. The main breaker and metering sections shall have doors with a minimum of five hinges. All doors, both front and rear, shall have the capability of being latched open greater than 90 degrees from the closed position. All bussing shall be copper. Easy access to the bus shall be made from rear door entrances. All control wiring shall be tie wrapped in plastic troughs and machine fastened to interior metal cabinet or struts in 10" intervals maximum. Adhesives shall not be permitted for securing control wiring. The exterior surface of the switchboard shall be free of any sheet metal fasteners or self threading screws. All enclosing metal

cabinets and doors shall be carriage bolted 11 gage steel. Roof and floor shall be constructed of 8 gage steel. All circuit breaker, current transformer or space compartments shall be fastened with self aligning bolts. Switchboards shall comply wit applicable articles of IEEE C37.

2.2.4.1 Switchboard Vertical Section

Each vertical section shall include:

a. Doors: Front, rear and all interior doors shall be furnished with full length hinges and have an open latched position greater than 90 degrees. Door knobs and rotating hardware shall be stainless steel. Doors shall have door keepers and louvers with replaceable fiberglass filters.

b. Lights: Each section vestibule shall be furnished with a fluorescent light and light switch.

c. Receptacles: One ground fault protected receptacle shall be provided in each one of the sections.

d. Heaters: Provide two stainless steel strip heaters, rated 1000 watts, 240V, operated on 120 volts, in each breaker compartment. Heaters shall be controlled by a thermostat and humidistat located inside the secondary switchboard section. Humidistats shall be industrial type, high limit, to maintain compartments within the range of 30 percent to 60 percent relative humidity. Electric heaters in switchboard assemblies shall be energized while the equipment is stored or in place prior to being placed in service.

e. Roof shall be sloped from front to rear.

2.2.4.1.1 Utility Control System (UCS) Components

The manufacturer of the switchboard shall provide the following related items in the switchboard for the utility control system:

a. Transducers, alarm contacts, metering and control devices, including those in the transformers and SF6 switches.

b. All wiring to and from transducers, circuit breaker alarm contacts, metering and control devices, located within the switchboard. All wiring inputs shall terminate at the terminal strips inside the utility control cabinet.

All metering components such as meters and transducers shall be located in one vertical section (utility control cabinet) with all field device terminal blocks for ct’s, transformer monitoring points, circuit breaker status. Provide a 3 foot by 3 foot space for mounting the future RTU adjacent the terminal blocks. Provide one thermostatically controlled heater and one heater controlled by a humidistat. Heater ratings shall be as specified above.

2.2.4.2 Secondary Main Circuit Breaker (More Than 2000 Amps))

UL listed stationary type, insulated case circuit breaker, manually operated, three pole, single throw with positive acting indication of breaker position. The continuous ampere rating shall be as indicated. All breakers shall be UL listed for application in their intended enclosure for 100% of their continuous ampere rating. Frame size and ampere ratings shall be as indicated on the drawings. Provide breaker A and B status contacts for UCS monitoring.

2.2.4.2.1 Interrupting Capacity

The interrupting capacity of the main circuit breaker shall be matched to the indicated bus rating.

2.2.4.2.2 Circuit Breaker Rating and Adjustment

The continuous ampere rating of the breaker shall be determined by the insertion of an interchangeable rating plug that matches the load and cable requirements. The rating plug shall be interlocked with a solid state tripping mechanism to automatically "open" the breaker when the plug is removed. The breaker shall remain "trip free" with the plug removed. In addition, rating plugs shall be keyed to prevent incorrect application between different frame ratings. Complete system selective coordination shall be provided by the addition of the following time/current curve shaping adjustments for phase currents:

a. Ampere setting
b. Long time delay
c. Short time pickup
d. Short time delay
e. Instantaneous

All adjustments shall be made using non-removable discreet step, high reliability switching plugs for precise settings. A sealable transparent cover shall be provided over the adjustment to prevent tampering. Access to adjust breaker setting shall be accomplished by removing the transparent cover only. Do not provide ground fault tripping.

2.2.4.2.3 Circuit Breaker Status Indication

The solid state trip unit devices shall be provided with two visual indicators to indicate the automatic tripping mode of the breaker (i.e. overload or short circuit).

2.2.4.2.4 Circuit Breaker Test Points

All breakers shall be provided with test points for in-service functional testing of the features provided. Provide 2 hand held test kits to test the above functions.

2.2.4.2.5 Circuit Breaker Operation

The breakers shall be capable of a minimum of 4000 interruptions of rated current followed by 4000 operations at no load without maintenance. Submit manufacturer’s certification. Further, the breaker shall be equipped with field replaceable contacts.

2.2.4.3 Secondary Main and Feeder Breakers (2000 Amps and Less)

Bolt-on type Fed. Spec.W-C-375B. Molded-case type. Circuit breakers shall have a quick-make, quick-break operating mechanism and shall be equipped with ambient-compensated thermal magnetic trip low to high settings. Provide ampere frame size and adjustable trip plug as indicated for all circuit breakers. Circuit breaker shall trip free of the handle, and the handle position shall indicate whether the breaker is "on", "off" or "tripped." Circuit breaker is to be mounted so that when removed the bussing will not be disturbed. An overload in one phase shall cause all three phases to trip. Short circuit bracing shall match the indicated bus brace rating. Provide breaker A and B status contacts for UCS monitoring.

2.2.4.4 Kilowatt-Hour Meters – SWITCHBOARD TYPE, CLASS 20, DEMAND TYPE

ANSI C12.1, ANSI C12.10, ANSI 12.16, ANSI C12.18, ANSI C12.19 ANSI c12.20, Type II, Class 3, Style B and shall have pulse module and load profile module with recording capability of 64k data storage. Kilowatt-hour meters shall be switchboard type totally compatible to each particular application. Kilowatt-hour meters shall be of one manufacturer. The meters shall have an electronic demand recording register and shall be secondary reading as indicated. The register shall be used to indicate maximum kilowatt demand as well as cumulative or continuously cumulative demand. Demand shall be measured on a block-interval basis. It shall have provisions to be programmed to calculate demand on a rolling interval basis. Enable TOU measurement module at the factory. Switchboard meters – 3-stator, 3 phase, 4-wire, 120 volt, class 20, and secondary type. Switchboard type case with paddle for meter removal incorporating automatically short-circuiting of current transformer circuits. Meter covers shall be polycarbonate resins with opcomport and reset. Battery mounting location shall be in the front. Provide blank tag fixed to the meter faceplate for the addition of the meter multiplier which will be the product of the current transformers and potential transformer ratio and will be filled in by PWC at the job site. The normal billing data scroll shall be fully programmable. Pulse module with programmable ratio selection. Meters shall be programmed after installation through opcomport. Liquid crystal display, 9 digits, blinking squares confirm register operation. Large digits for data and smaller digits for display identifier. Wire KYZ output to the utility control cabinet.

2.2.4.5 Fuse Blocks

Pullout type, 30 amp rating, NEMA Class J with fuses, 3 pole.

2.2.4.5.1 Fuses

Pull out type, NEMA Class J, current limiting.

2.2.4.6 Terminal Boards/Blocks

Terminal boards shall be bolt on type 240 volt, 30 amp for lay down on control systems wiring. Provide with engraved plastic terminal strips and screw type terminals for external wiring between components and for internal wiring between removable assemblies. Terminal blocks associated with current transformers shall be short circuiting type, 6 circuit, compatible

with current transformer wiring systems and shall have shorting bars with shorting screws. Terminate conductors for current transformers with ring-tongued lugs. Each block shall be secured to the compartment by mechanical means. Terminal boards identification shall be identical in similar units. External wiring shall be color-coded consistently for similar terminal boards. Terminal boards/blocks shall be arranged so that access to them shall be in the front of the switchboard only within the utility control cabinet.

2.2.4.7 Wire Marking

Mark control and metering conductors at each end. Provide factory-installed, white plastic tubing, heat shrink with black block type letters on factory-installed wiring. On field-installed wiring, provide white, preprinted, polyvinyl chloride (PVC) sleeves, heat stamped with black block type letters. Each sleeve shall contain a single letter or number. Provide specific wire markings using the appropriate combination of individual sleeves. Each wire marker shall indicate the device or equipment, including specific terminal number to which the remote end of the wire is attached.

2.2.4.8 Switchboard Wiring

Cell and panel control wiring shall be run in plastic wiring trough having slots at each side for branching of the wires. Wiring to the hinged panels shall be carried across the hinges in laced bundles arranged so that the wires twist rather than bend. All wiring shall be correctly and clearly identified with letters and/or numbers at each end of the wire. The wire marker shall show the origination and destination. Provide identified terminal boards with engraved plastic terminal strips for external wiring between components and for internal wiring between removable assemblies. Terminal board identification shall be identical in all similar units. Color code external wiring consistently for all similar terminal boards. Switchboard control wiring shall terminate at terminal boards with ring-tongue terminals. Control circuit terminations shall be properly identified.

2.2.4.9 Control Cable

Control cable shall be stranded “SIS” type, except for analog utility control circuits. Conductors shall be copper, and shall be #12 AWG minimum. Conductors shall be color coded per contract drawings or labeled on each end. Control cable for analog transducer circuits shall be #18 copper twisted and shielded pairs rated for 300 volts. All devices shall be wired to the utility control cabinet. Control circuit terminations shall be properly identified.

2.2.4.10 AC Voltmeter

Transformer rated, 250 volt, 60 Hz input, 4 inch for use with 288 to 120 volt potential transformers. Provide external dropping resistor if required. Voltmeter shall provide +1 percent accuracy at full scale. Scale shall span 250 degrees. Mounting shall be flush type.

2.2.4.11 Voltmeter Switch

Voltmeter switch shall be designed specifically for the purpose and shall have seven positions, one position for each phase to neutral and one

position for each phase to phase and “off”. Contacts shall be rated for 20 amperes, 600 volts AC. Switch shall have metal shaft and removable handle.

2.2.4.12 Potential Transformer

Potential transformers shall be rated for interior use. Voltage rating shall provide 120 volts, 3 phase, 4 wire, 60 Hertz, wye to kilowatt-hour meter, insulation class, 600 volts. Potential transformers BIL shall be 10 KV and accuracy class 0.3 at burdens w, x and y. Thermal rating shall be 500 VA.

2.2.4.13 Voltage Transducer

Voltage transducer wiring shall be connected to a potential transformer. Provide three (3) spare transducers for each switchboard. Transducer housing shall be constructed of ferrous metal. The voltage Transducer shall include the following features: Full scale shall be 150 volts. Load shall be single phase. Potential input shall be 115 VAC. Potential burden shall be a maximum of 2.5 VA at 120 volts. Burden shall be 0.1 VA per element at 120 volts, 2 VA per element with 5 amperes input. Output shall be 4-20mA DC. Accuracy/Linearity at 25 deg C: +0.25% at rated output, 0.5% of full scale includes, influences due to variation in voltage, current, power factor, wave form, frequency and output load impedance. Operating temperature range 0 degree F to 150 degree F, 400 ms for output to register 99% of final value. Frequency range shall be 58-62 Hz. AC component range shall be 0.5% of maximum output. Power factor range shall be Unity to load or lag zero. Calibration adjustment shall be +10%. Zero adjustment is not required. Dielectric strength shall be 1800V RMS at 60 Hz between each input circuit and all other components. External amplifier power of 120V is required.

2.2.4.14 AC Ammeter

Transformer rated, 5 amperes, 60 Hz input, 4 inch for use with current transformers. Ammeter shall provide +1 percent accuracy at full scale. Scale shall span 250 degrees. Mounting shall be flush type.

2.2.4.15 Ammeter Switch

Ammeter switch shall be designed specifically for the purpose and shall short circuit all current circuits except the one being read. Contacts shall be rated for 20 amperes, 600 volts AC. Switch shall have 4-position escutcheon indicating each phase and “off”. Switch shall have metal shaft and removable handle.

2.2.4.16 Current Transformers

Current transformers for metering application shall be multi-ratio type, with a minimum of 9 ratios, 5 terminals, rated for interior use. Insulation class rating shall be 600 volts, 60 hertz, and shall have an accuracy classification of 0.3 for ANSI standard burdens. Current transformer ratios shall be set as indicated on the drawings and if not on the drawings, set to match circuit breaker trip settings. Current transformers shall be bracket or rack mounted in secondary cabinets and positioned to allow cables to easily route through the current transformer opening. Integral circuit breaker current transformers shall not be used for metering. Installation of current transformers shall have all ratios brought out to individual shorting

blocks, each wire shall be identified on both ends. Use ring type lugs. Current transformer installation shall have H1 side of the current transformer facing power source. At shorting terminal block provide ground jumper on the 6th terminal and ground the current transformer on the side of the shorting terminal block which is wired to the KWH meter or amp transducer. Provide the following:

Multi-ratio	Current Rating Amperes (RATIOS)	Taps
600 to 5	50 to 5	2 and 3
	100 to 5	1 and 2
	150 to 5	1 and 3
	200 to 5	4 and 5
	250 to 5	3 and 4
	300 to 5	2 and 4
	400 to 5	1 and 4
	450 to 5	3 and 5
	500 to 5	2 and 5
	600 to 5	1 and 5
1200 to 5	100 to 5	2 and 3
	200 to 5	1 and 2
	300 to 5	1 and 3
	400 to 5	4 and 5
	500 to 5	3 and 4
	600 to 5	2 and 4
	800 to 5	1 and 4
	900 to 5	3 and 5
	1000 to 5	2 and 5
	1200 to 5	1 and 5
2000 to 5	300 to 5	3 and 4
	400 to 5	1 and 2
	500 to 5	4 and 5
	800 to 5	2 and 3
	1100 to 5	2 and 4
	1200 to 5	1 and3
	1500 to 5	1 and 4
	1600 to 5	2 and 5
	2000 to 5	1 and 5
3000 to 5	300 to 5	3 and 4
	500 to 5	4 and 5
	800 to 5	3 and 5
	1000 to 5	1 and 2
	1200 to 5	2 and 3
	1500 to 5	2 and 4
	2000 to 5	2 and 5
	2200 to 5	1 and 3
	2500 to 5	1 and 4
	3000 to 5	1 and 5

4000 to 5	500 to 5	1 and 2
	1000 to 5	3 and 4
	1500 to 5	2 and 3
	2000 to 5	1 and 3
	2500 to 5	2 and 4
	3000 to 5	1 and 4
	3500 to 5	2 and 5
	4000 to 5	1 and 5

2.2.4.17 Current Transducer

Feeder amperage shall be monitored by current transducers as shown on the control drawings. Wiring input shall be connected to current transformer. Provide three (3) spare transducers for each switchboard. Transducer housing shall be constructed of ferrous metal. Ampere transducers shall be single element, constant current output and shall have characteristics equal to or better than the following: Input current shall be 0-5 amperes AC single phase measurements. Input shall be capable of continuously carrying 10 amperes AC or withstanding 250 amperes AC for 1 second. Output current shall be 4-20 milliamps (mA) DC. Calibration adjustment shall be +2% minimum. Output ripple shall be 0.5% maximum. Response time shall be 0.1 seconds for output to register 99% of a sudden input change. Accuracy/Linearity 25-1/4C shall be +0.5 of full scale overall between 0-5 amperes, load variation of 0-108 ohms and frequency variation of 50-500 Hz. Temperature effect shall be +1% maximum between –20 degree C to 60 degree C. Humidity effect shall be 0.05% without condensation. Burden shall be 1 VA maximum. Voltage input shall be nominal 120V at a range of 85-135V and shall be capable of withstanding 175V overload continuously.

2.2.4.18 Control Power transformer

NEMA ST 20, rated 7.5 kVA, 1-phase, 3-wire, 60 hertz, dry-type, 480 primary volts to 120/240 secondary volts complete with primary current limiting fuses and secondary molded case circuit breakers. Wire using 3-#6 THW on both primary and secondary. Transformers shall be accessible from the front and in NEMA 1 housing.

2.2.5 Pad-Mounted SF6 (Sulfur Hexafluoride) Insulated Interrupter Switch

ANSI C37.71 and ASTM D 2472. The SF-6 gas switch shall be rated for 600 amperes, 15,500 volts 110kV BIL, 40 KA momentary and fault close asymmetrical rating. Switches shall be three-pole, multi-way type as shown on the drawings, with two operating positions identified as OPEN, and CLOSED. Viewing windows (minimum two per tank) shall be provided for inspection of all operating positions. These windows shall be bolt-mounted type with retained and cushioned gaskets. Individual switch blades or links shall be provided for each incoming feeder. The switches shall be load-break type assemblies with external operating handles, and switch blade contact arrangements as shown on the drawings. Contact shall be self-aligning, silver-plated copper type with arc shields to minimize contact wear. Contact travel shall be clearly visible through the viewing windows. Contacts shall be rated for 500 service operations. Each switch tank shall be constructed of minimum 6.35mm-thick welded steel plate, welded at all joints. The tank shall be suitable for frame mounting. A gas pressure gauge with a 4-20mA output shall be provided and wired to the utility control cabinet. The switch shall be provided with a fill valve, plug, air

test fittings, lifting eyes, ground bus, grounding provisions, one line diagrams, operating handle, and compression spring operator. A galvanized steel angle and/or channel frame allowing 48" from finish grade to high voltage bushings shall be provided. Low profile type or integral door type switches are not acceptable. The switch tank shall be bolted to the frame. Additional outdoor weather-proof 11 gauge steel enclosure with doors and padlockable handle shall be provided as shown on drawings. Parking stands shall be provided to "Park" cables after removal. Color of switch enclosure shall match unit substation color. Mount switch on concrete pad at least 203 mm thick. Provide bare copper cable, not less than 610 mm below connected to ground rods and each switch way.

2.2.5.1 Cable Termination

The switch shall have field replaceable (from exterior of tank) 600 Amp apparatus bushings, complete with elbow connectors for rear connection of cables. Bushings and connectors shall be rated for 25 kV operation. Connectors shall be capable of accepting 3/0 to 750 MCM cables. All cables shall be marked by phase, for each terminator location. The switch compartments shall not be utilized as splicing junction boxes.

2.2.5.2 Circuit Diagram

Circuit diagram with circuits labeled per contract drawings, nameplate indicating manufacturer and switch rating as specified above shall be provided. Include pad labels and circuit numbers.

2.2.5.3 Elbow Connector and Accessories

IEEE 386. Apparatus (elbow) connectors shall be a fully shielded, fully submersible, hot stick operable, separable insulated connector, designed for de-energized operation. The connector shall be designed to terminate specified cable. The connector shall consist of a housing, conductor contact, male contact, and bail assembly. The housing shall be made of a specially molded, non-tracking type rubber with an outer conductive jacket 1/8 inch thick. The contacts shall be high conductive, silver plated copper with compression disc washers to insure positive contact pressure when engaged. The connectors shall be rated as follows:

Continuous Load Current	600A RMS
8-Hour Overload Current	900A RMS
Voltage Nominal	25kV
Phase to Ground Voltage	14.4kV minimum
Impulse Withstand Voltage (BIL)	125kV, 1, 2 x 50 wave
Withstand Voltage	42kV, 60HZ, 1 Min. 80kV, DC, 15 Min.
Corona Extinction	40000 RMS Asymmetrical for 12 Cycles

2.2.5.4 Accessories

a. Basic insulating plugs, dead end plugs and connecting plug shall be fully shielded, fully submersible devices to interface the apparatus connectors. The electrical rating shall be the same as for apparatus connectors. Provide one (1) for each unused bushing.

b. Shield adapter and grounding device shall be furnished for intercepting cable shielding and proper grounding.

c. All premolded products such as basic insulating plugs, dead end plugs, connecting plugs, end caps, shield adapters, and grounding devices shall be the product of one manufacturer.

d. Provide three (3) spare elbow connectors for each switch and turn these over to the Contracting Officer.

3 EXECUTION

3.1 EXAMINATION

3.1.1 Verification of Conditions

Coordinate the electrical work with the work of other trades at the jobsite to ensure that components which are to be incorporated into the electrical system are available to prevent delays or interruptions as the work progresses. Verify that conditions are suitable for installation of the electrical system.

3.1.2 Installation Underground

3.1.2.1 Underground Duct with Concrete Encasement

Ducts for electrical power distribution shall not be smaller than 127 mm in diameter. The concrete encasement surrounding the bank shall be rectangular in cross-section. Separate conduits by a minimum concrete thickness of 63.5 mm, except separate power conduits from control conduits by a minimum concrete thickness of 76.2 mm.

The top of the concrete encasement shall not be less than 457 mm below grade except that under roads and pavement it shall be not less than 610 mm below grade.

3.1.2.2 Meters and Current Transformers

Provide in accordance with ANSI C12.1.

3.1.2.3 Foundation for Equipment and Assemblies

Mount transformer on concrete slab. The slab shall be at least 203 mm thick, reinforced as indicated. If reinforcement is not indicated then provide slab with a 152mm by 152 mm - W2.9 by W2.9 mesh placed uniformly 102 mm from the top of the slab. Slab shall be placed on a 152 mm thick, well-compacted gravel base. The top of the concrete slab shall be approximately 102 mm above the finished grade. Edges above grade shall have 12.7 mm chamfer. The slab shall be of adequate size to project at least 203 mm beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 76.2 mm above slab surface. Provide curbing to contain transformer oil leaks.

3.1.2.4 Grounding Electrodes

Provide cone pointed driven ground rods driven full depth plus 152 mm, installed to provide an earth ground of the value before stated.

3.1.2.5 Pad Mounted Transformer Grounding

Provide ground loop around the pad perimeter consisting of four ground rods located at opposite corners, connected with No. 4/0 bare copper grounding conductors. Provide copper grounding conductors and connect them to the ground loop. Provide a ground conductor from the transformer secondary neutral to ground loop sized in accordance with NFPA 70. All connections shall be made with exothermic welding. Grounding conductor from transformer secondary neutral shall be insulated and run to the ground loop separate from arrester and ground pad conductor. The ground loop, surge arrester conductor, and conductor from transformer ground pads to ground loop shall be No. 4/0 bare copper. When additional work is required to obtain the specified ground resistance, the provision of the contract covering "Changes" shall apply.

3.1.2.6 Fence Grounding

Fences around electrical equipment shall be grounded with a ground rod at each fixed gate post and at each corner post. Drive ground rods adjacent to the ground loop until the top is 304.8 mm below grade. Attach the ground rod to the ground loop by exothermic welding. Attach a No. 4/0 bare copper conductor by exothermic fusion weld process, to the ground rods and extend underground to the immediate vicinity of fence post. Lace the conductor vertically into 304.8 mm of fence mesh and fasten by two exothermic welds, one to bond wire to post and the other to bond wire to fence. Each gate section shall be bonded to its gatepost by a 3 mm by 25.4 mm flexible braided copper strap and ground post clamps. Clamps shall be of the anti-electrolysis type.

3.1.3 ACCEPTANCE TESTING

The Contractor shall engage the services of a recognized independent testing firm or independent electrical consulting firm to perform short-circuit and coordination studies as herein specified. The Contractor shall engage the services of a recognized independent testing firm for the purpose of performing inspections and tests as herein specified. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such inspections and tests. The inspections and tests shall determine suitability for energization. An itemized description of equipment to be inspected and tested is as follows:

12KV Cable and terminations
Pad Mounted transformer
SF6 switches
Secondary distribution sections.
Circuit Breakers, 100 amp trip and larger.
Instrument Transformers
Metering Systems.
Grounding Systems

3.1.3.1 APPLICABLE CODES, STANDARDS, AND REFERENCES

InterNational Electrical Testing Association Acceptance Testing Specifications For Electric Power Distribution Equipment and Systems, 1999.

All inspections and tests shall be performed in accordance with applicable codes and standards including: NEC, ANSI, IEEE, NFPA, NEMA, and OSHA.

3.1.3.2 QUALIFICATIONS OF INDEPENDENT TESTING ORGANIZATION

The independent testing organization shall have been engaged in full practice in the final inspection, testing, calibration, and adjusting of electrical distribution systems, for a minimum of ten years. The independent testing organization shall be financially independent of the supplier, producer, or installer of the equipment. The independent testing organization shall have a calibration program with accuracy traceable every six months in an unbroken chain, to the National Institute of Standards and Technology.(NIST) The independent testing organization shall have a designated safety representative on the project. The safety standards followed shall include OSHA and NFPA 70E. Inspection, testing, and calibration shall be performed by an engineering technician, certified by a national organization, with a minimum of five years experience inspecting, testing, and calibrating electrical equipment, systems and devices. Information on the certified engineering technician shall be submitted to the Contacting Officer’s Representative for approval prior to the start of work. The qualifications of the independent testing organization shall be submitted to the Contracting officer’s representative for approval prior to the start of testing. Full membership in the InterNational Electrical Testing Association constitutes proof of meeting all of the above requirements. The contractor shall supply to the independent testing organization complete sets of approved drawings, coordination study, settings of all adjustable devices, and other information necessary for an accurate inspection and evaluation of the system prior to performance of any tests. After the evaluation of the system and equipment has been made, the independent testing organization shall submit for approval an acceptance test procedure for each item of electrical distribution equipment to be tested on this project. No testing shall be performed until the test procedures have been approved.

3.1.3.3 RESPONSIBILITY

The contractor shall perform routine insulation resistance, continuity, and rotation tests for all distribution and utilization equipment prior to and in addition to tests performed by the independent testing organization specified herein. The contractor shall supply a suitable and stable power source of electrical power to each test site. The independent testing organization shall specify the specific power requirements. The independent testing organization shall notify the contracting officer’s representative prior to commencement of any testing. Any system, material, or workmanship which is found defective on the basis of acceptance tests shall be reported. The independent testing organization shall maintain a written record of all tests and shall assemble and certify a final test report. The independent testing organization shall have a designated safety representative on the project to supervise operations with respect to safety.

3.1.3.4 REPORT SUBMITTALS

Six bound copies of the certified test reports shall be submitted to the Government at the completion of the project. The final report shall be signed and stamped by a registered engineer and shall include the following information:

Summary of the project

Description of equipment tested
Visual inspection report
Description of tests
Test results
Conclusions and recommendations
Appendix including appropriate test forms
Identification of test equipment used

3.1.3.5 INSPECTION AND TEST PROCEDURES

Perform all tests, including any optional tests listed in NETA ATS-1999. This applies to all equipment provided on the project.

3.1.4 Devices Subject to Manual Operation

Each device subject to manual operation shall be operated at least three times, demonstrating satisfactory operation each time.

End of Section